

**What is claimed is:**

1. A lapping apparatus comprising:
  - a lapping film;
  - a film feeder configured to feed the film;
  - 5 a first drive configured to rotate a work;
  - a second drive configured to move the work relative to the film;
  - a shoe set;
  - a shoe set handler configured to handle the shoe set to press the film against the work;
  - and
  - 10 a deterioration delayer configured to delay an abrasivity deterioration of the film.
2. The lapping apparatus as claimed in claim 1, wherein
  - the shoe set comprises a first shoe of a width, and a second shoe of the width at a
  - distance of the width times an integer from the first shoe, and
  - 15 the deterioration delayer comprises a controller configured to control the film feeder to
  - feed the film at a distance of the width.
3. The lapping apparatus as claimed in claim 2, wherein
  - the shoe set comprises a number of shoes equal to the integer .
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4. The lapping apparatus as claimed in claim 2, wherein
  - the shoe set comprises a first shoe set, and a second shoe set, and
  - the deterioration delayer comprises a detector configured to detect a condition of an
  - abrasive face of the film between the first shoe set and the second shoe set, and
  - 25 the controller is configured to control the film feeder in dependence on the condition
  - detected by the detector.
5. The lapping apparatus as claimed in claim 1, wherein
  - the shoe set comprises a first shoe set, and a second shoe set, and
  - 30 the deterioration delayer comprises a cleaner configured to clean an abrasive face of

the film between the first shoe set and the second shoe set.

6. The lapping apparatus as claimed in claim 5, wherein  
the deterioration delayer comprises a film warper configured to warp the film with the  
5 abrasive face outside.
7. The lapping apparatus as claimed in claim 5, wherein  
the cleaner comprises an ultrasonic brush.
- 10 8. The lapping apparatus as claimed in claim 5, wherein  
the cleaner comprises an ultrasonic bath.
9. The lapping apparatus as claimed in claim 5, wherein  
the cleaner comprises a jet nozzle.
- 15 10. The lapping apparatus as claimed in claim 5, wherein  
the film comprises a flexible and non-expansive substrate.
11. The lapping apparatus as claimed in claim 1, wherein  
20 the shoe set comprises a first shoe, and a second shoe, and  
the deterioration delayer comprises a first detour provider configured to provide the  
film with a first detour defining a first space between the first shoe and the second shoe, and a  
lubricant supplier configured to supply a lubricant to the first space.
- 25 12. The lapping apparatus as claimed in claim 11, wherein  
the film comprises a flexible and non-expansive substrate .
13. The lapping apparatus as claimed in claim 11, wherein  
the shoe set comprises a third shoe,  
30 the deterioration delayer comprises a second detour provider configured to provide the

film with a second detour defining a second space between the second shoe and the third shoe,  
and

the lubricant supplier is configured to supply the lubricant to the second.

5           14. The lapping apparatus as claimed in claim 11, wherein  
the first detour provider comprises a tension roller configured for the first detour to  
detour therearound, and a bias element configured to bias the tension roller in a detoured  
direction of the first detour.

10           15. The lapping apparatus as claimed in claim 14, wherein  
the tension roller is rotatable.

16. The lapping apparatus as claimed in claim 11, wherein  
the deterioration delayer comprises a shoe case having a first support part configured  
15 to support the first shoe, and a second support part configured to support the second shoe, the  
first and second support parts extending in radial directions of the work defining therebetween a  
slot configured to accommodate the first detour and the first detour provider resiliently  
suspended from the shoe case.

20           17. The lapping apparatus as claimed in claim 16, wherein  
the lubricant supplier comprises a network of lubricant paths formed in the shoe case  
and communicating with the first space.

18. The lapping apparatus as claimed in claim 11, wherein  
25 the lubricant supplier is configured to deliver the lubricant from around the first detour  
provider.

19. The lapping apparatus as claimed in claim 1, wherein  
the deterioration delayer comprises a film oscillator configured to oscillate the film at a  
30 higher speed in a feed direction of the film than a rotational speed of the work.

20. The lapping apparatus as claimed in claim 19, wherein  
the second drive comprises a work oscillator configured to oscillate the work relative  
to the film in a direction of an axis of rotation of the work.

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21. The lapping apparatus as claimed in claim 19, wherein  
the film oscillator comprises an oscillating film drawer configured with a film roller  
having the film detoured therearound through the shoe set, and a radial oscillator configured to  
oscillate the film roller in a first radial direction of the work, and a tensioning film drawer  
10 configured with a tension roller having the film detoured therearound through the shoe set, and a  
bias element configured to resiliently bias the tension roller in a second radial direction of the  
work different from the first radial direction.

22. The lapping apparatus as claimed in claim 21, wherein  
15 the film oscillator comprises the oscillating film drawer, another oscillating film  
drawer, and tensioning film drawer disposed therebetween.

23. The lapping apparatus as claimed in claim 19, wherein  
the film feeder comprises a film locker configured to lock the film at a first acting  
20 point on the film, and  
the film oscillator comprises a tension controller configured to control a tension of the  
film at a second acting point on the film between the first acting point and the shoe set.

24. The lapping apparatus as claimed in claim 19, wherein  
25 the film comprises a flexible and non-expansive substrate.

25. The lapping apparatus as claimed in claim 1, wherein  
the deterioration delayer comprises a film detector configured to detect a condition of  
an abrasive face of the film, and a controller configured to control one of the film feeder and the  
30 shoe set handler depending on the condition detected.

26. The lapping apparatus as claimed in claim 25, wherein  
the condition detected comprises a projection of an abrasive particle of the abrasive  
face.

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27. The lapping apparatus as claimed in claim 25, wherein  
the deterioration delayer comprises a truer configured to true the abrasive face  
depending on the condition detected.

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28. The lapping apparatus as claimed in claim 25, wherein  
the film detector is configured to detect the condition of the abrasive face before a  
lapping service.

29. The lapping apparatus as claimed in claim 25, wherein  
15 the film detector is configured to detect the condition of the abrasive face after a lapping service.

30. The lapping apparatus as claimed in claim 1, wherein  
the shoe set comprises a convex shoe,  
the shoe set handler comprise a shoe floater configured to float the shoe, and  
20 the deterioration delayer comprises a controller configured to control a location of  
contact between the shoe, the film, and the work.

31. The lapping apparatus as claimed in claim 30, wherein  
the controller comprises a detector configured to detect a position of the work, and a  
25 drive configured to drive the shoe to change the location of contact depending on the position  
detected.

32. The lapping apparatus as claimed in claim 30, wherein  
the floater comprise a pair of springs suspending the shoe, and  
30 the controller is configured to control positions of the pair of springs to change a

position of the shoe.

33. The lapping apparatus as claimed in claim 32, wherein the pair of springs have different spring constants.

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34. The lapping apparatus as claimed in claims 30, wherein the film comprises a flexible and non-expansive substrate.

35. The lapping apparatus as claimed in claim 1, wherein the deterioration delayer comprises a blocking delayer configured to delay a blocking of the film.

36. A lapping apparatus comprising:  
a lapping film;  
film feeding means for feeding the film;  
first drive means for rotating a work;  
second drive means for moving the work relative to the film;  
a shoe set;  
shoe set handling means for handling the shoe set to press the film against the work;  
and  
deterioration delaying means for delaying an abrasivity deterioration of the film.

37. A lapping method comprising:  
feeding a lapping film;  
rotating a work;  
moving the work relative to the film;  
handling a shoe set to press the film against the work; and  
delaying an abrasivity deterioration of the film.

38. The lapping method as claimed in claim 37, wherein

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the shoe set comprises a first shoe of a width, and a second shoe of the width at a distance of the width times an integer from the first shoe, and

the delaying comprises controlling the film feeder to feed the film at a distance of the width.

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39. The lapping method as claimed in claim 38, wherein  
the shoe set comprises a number of shoes equal to the integer.

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40. The lapping method as claimed in claim 37, wherein  
the shoe set comprises a first shoe set, and a second shoe set, and  
the delaying comprises detecting a condition of an abrasive face of the film between  
the first shoe set and the second shoe set, and  
the controlling comprise depending on the condition detected.

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41. The lapping method as claimed in claim 37, wherein  
the shoe set comprises a first shoe set, and a second shoe set, and  
the delaying comprises cleaning an abrasive face of the film between the first shoe set  
and the second shoe set.

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42. The lapping method as claimed in claim 37, wherein  
the shoe set comprises a first shoe, and a second shoe, and  
the delaying comprises providing the film with a detour defining a space between the  
first shoe and the second shoe, and supplying a lubricant to the space.

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43. The lapping method as claimed in claim 37, wherein  
the delaying comprises oscillating the film at a higher speed in a feed direction of the  
film than a rotational speed of the work.

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44. The lapping method as claimed in claim 37, wherein  
the delaying comprises detecting a condition of an abrasive face of the film, and

controlling one of feeding and handling depending on the condition detected.

45. The lapping method as claimed in claim 37, wherein  
the shoe set comprises a convex shoe,  
5 the handling comprise floating the shoe, and  
the delaying comprises controlling a location of contact between the shoe, the film,  
and the work.